Snubfin dolphin census in Yawuru Nagulagun/ Roebuck Bay

Photo Ellen D’Cruz: Leroy Pigram photographing snubfin dolphin dorsal fin for the census.

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Non-technical summary

A census of snubfin dolphins was undertaken in Yawuru Nagulagun/Roebuck Bay Marine Park (YNRBMP) in May 2022. The census involved vessels following line transect surveys where observers recorded all sightings of dolphins. Photographs were taken of the dorsal fins of all dolphins to identify individuals based on the unique shape and markings on their fins. This information can be used to assess the number of dolphins using the Bay over the time period of the census and to gather life history information on individual snubfins.

Three DBCA vessels covered a total of 754 km over four days (2-4th & 6th May 2022), equating to 54 hours on the water. Of this 439 km and 32 hours was dedicated to searching for dolphins along transect lines. This survey effort achieved was less than in 2019 (604km of survey transect lines over three days 4-6th April 2019, equating to 49 hours searching for dolphins). The snubfin dolphin (*Orcaella heinsohni)* was the only dolphin species sighted during the census from the DBCA vessels. In addition to the DBCA vessels, one of the Commercial Tour Operators (CTOs) took out Dolphin Watch volunteers to record dolphin sightings on Wednesday 4th May. The CTO vessel recorded a sighting of bottlenose dolphins (*Tursiops aduncus*) as well as several snubfin dolphin sightings. The overall census resulted in sightings of 35 dolphin groups that included 169 dolphins (note that this includes resightings of some individuals over multiple days and while 113 were found along transects, 56 were not). This resulted in an encounter rate of 0.22 dolphins per km including when off transect lines and outside the pre-determined survey area or 0.25 per km only along the transect lines. A higher density of snubfin dolphins was found around Crab Creek and the eastern side of the Bay over the extensive mud flats in water <5 metres throughout the census.

Most snubfin dolphins (83%; 72) had scars or marked dorsal fins, making it possible to recognise them as individuals and making them potentially recognisable in the future if the marks remain stable. A total of 72 individual snubfin dolphins could be identified by their markings and some individuals were sighted over multiple days (e.g., resightings). An additional 15 individuals with unmarked 'clean' fins (these were identified as individuals using markings on the body or temporary markings on the dorsal fin surface e.g. lesions, teeth rake marks but these marks are known to fade quickly over days to months and included calves that were identified maintaining close proximity and 'baby position' with their mother despite not having distinct markings themselves) were sighted over the census period for a total of 87 snubfin dolphins in Roebuck Bay during the census. This is a similar result to the 2019 census where 80 marked individual dolphins were photographed and identified (96 including the calves and 'clean fins'). Of the 72 individual snubfins identified in 2022, 44% (32) have been seen in previous surveys. One individual commonly known as Grunge (ID rb025oh) was first sighted on 8th May 2007, has been seen repeatedly over the intervening 15 years and was sighted on three of the four survey days this year. This second rapid population census done with high intensity survey effort over a short period (days) seems an appropriate approach to monitoring trends in abundance of the snubfin population over time (years). We recommend that the census-style survey is repeated every 2-3 years (maximum 5 yearly) to ensure that any changes to dolphin populations would be detected and managed. Regular survey effort will also be necessary to track the evolving dorsal fins ('natural tags') as the rate of change to the snubfin dorsal fins is apparently highly variable (unpublished data) but presumably are relatively unchanged over weeks to months. Understanding how many dorsal fins are changing and the rate of change will be important for demographic studies on the individual life histories of snubfins. Photographing dolphins from tour operator vessels by Nyamba Buru Yawuru country managers may be a mutually beneficial activity of monitoring the snubfin dolphins on Yawuru Nagulagun (sea country). Dolphin Watch volunteers that have been trained in the Dolphin Watch app

could also contribute valuable data, particularly with high resolution dorsal fin photos, to complement the periodic high intensity census surveys and more regular joint management monitoring activities in the YNRBMP.

Introduction

The management plan for the Yawuru Nagulagun/ Roebuck Bay Marine Park (YNRBMP), gazetted in 2016, recognizes snubfins as a key value within the marine park with targets to maintain their abundance. The Roebuck Bay population is also identified as a national priority for long term monitoring in the National Tropical Dolphin Strategy. This population has been the subject of research by various independent scientists over the years that have contributed knowledge on population size, distribution across YNRBMP and identification of individuals based on scars and markings to their dorsal fins. A photo ID catalogue ("Finbook") containing photos of over two hundred individual snubfin dolphin dorsal fins was published under the DBCA Dolphin Watch Program as a tool to assist in the ongoing monitoring and management of the snubfin dolphin population using their natural marks as tags. These photo-identification images are curated by the Marine Science Program using the DolFIN database.

The baseline abundance estimate of ~130 individuals was provided by (Brown et al., 2014a, Brown et al., 2014b) for this population, using mark-resight modelling. However regular monitoring is required to ensure that the population is stable and maintained long term, particularly as pressures increase in the region. An inaugural rapid census assessment was trialed in April 2019 as an alternative to the effort intensive mark-resight surveys previously conducted. Given the success of the 2019 survey, we repeated the rapid population census in May 2022 to provide a direct count of how many snubfins were in Roebuck Bay at the time of the census and to better understand whether any of the same individuals were present that were there in 2019. This approach provides:

1. a complete snapshot of the number of snubfins using Roebuck Bay at a given time,
2. new information on population demographics,
3. capacity building for the marine park joint partners that participated in the surveys,
4. and it meets Departmental communication and education objectives by involving the community in citizen science.

Methods

Study area

Roebuck Bay is a large tropical embayment (~500 km^2) adjacent to the township of Broome in the Kimberley Region (Figure 2). The Bay is fed by freshwater inputs from Dampier and Crab creeks as well as many smaller tributaries. The coastal edge of the Bay is relatively shallow <10 m water depth at lowest astronomical tide but the Bay is subject to some of the largest tidal movement in the world with a maximum of 10 metres during spring tides, meaning that a large portion of the bay is exposed mud flat at low tide. The benthic substrate is predominantly mud and silt interspersed with seagrass and mangroves lining the periphery of the Bay.

Data collection

The survey was planned to coincide with spring tides to minimise the habitat available for snubfins to be surveyed. We concentrated our survey effort in the northern portion of the Bay (~100 km^2) and followed the same two transects designed by Brown et al. (2016) with additional transects added to cover the middle and southern sections of the Bay (Figure 2). The rationale behind the zig zag transect design is to cover the depth gradient in the Bay. Many coastal cetaceans show a density gradient from high density nearshore to low density offshore, so transect lines perpendicular to shore are preferred over lines parallel to shore (Dawson et al., 2008). These additional transects were added to cover more of the Bay and a broader range of habitat types to get a better understanding of snubfin distribution across the Bay and identify important habitats. Pre-determined transects were used to achieve even coverage across the Bay and to ensure data were comparable to Brown et al. (2016). Surveys were conducted and data collected over a five day period including three consecutive days from 2-4th and a final day on the 6th May 2022 (strong winds prohibited surveying on Thursday the 5th May). This time of year, Yawuru season Wirralburu, was chosen to ensure the best chance of suitable weather for a survey (low winds (sea state <3) and no rain) and to be comparable to previous surveys Brown et al. (2016). .

The research teams consisted of at least three people on each vessel including a photographer & data recorder, crew and field support. Each team included staff from West Kimberley District, Marine Science Program and NBY country managers. Surveys were only undertaken in suitable weather conditions, Beaufort 3 or less and during daylight hours. At the beginning of each survey, each DBCA vessel was allocated a different transect to cover (Figure 2) to achieve spatial separation across the survey area. Vessels maintained 8-10 kt while on transect but slowed during dolphin sightings and transited between transects at faster speeds. A GPS onboard the vessel was set to automatically record the position of the vessel every 30 seconds to create a record of the actual survey track followed throughout the day so that the total distance on and off survey effort could later be calculated. It was noted when a transect was started and completed as this was considered 'on effort' during the survey and transits between transects, deviations off transects and during group encounters was considered 'off effort.'

A minimum of three people were onboard each vessel including the skipper and two observers dedicated to scanning for dolphins (with the naked eye) ahead and on each side of the vessel. When dolphins were sighted the point where the transect was left was noted by the skipper using the onboard navigation system and the dolphin group was approached to collect data on group size, composition (i.e. species, sex and age class) and behavioural activity. The location (latitude and longitude) of the sighting was recorded using a hand-held Garmin GPS. Photographs of the dorsal fins of all dolphins in the group were taken for the purpose of photo-identification of individual animals. A dolphin group was defined as members within 100 m of each other and engaged in the same behavioural activity, as per Parra (2006). Each vessel had at least one person using a DSLR camera with a 400 mm zoom lens for photo-identification.

Community engagement

During one day of the census, the CTO vessel for Absolute Ocean Charters '*Contessa C*' a 20m monohull aluminium cruiser, took a group of registered Dolphin Watch volunteers and DBCA Dolphin Watch staff to record dolphin sightings using the Marine Fauna Sightings app. The CTO vessel concentrated in the north-eastern portion of the Bay in their normal area of operation and did not follow pre-determined transects or speed restraints.

Analysis - Distribution of sightings, group sizes and encounter rates

All effort (vessel time and distance covered) was then summed to calculate a total effort (hours and linear distance in km, excluding the CTO vessel) for the entire census including on survey (along transects) and off survey (transits). The total number of snubfins (including dependent calves) recorded during the survey was then divided by the total survey effort (linear distance) to produce a metric of number of snubfins encountered per km both overall and for only survey effort along transects. Maps were produced illustrating the locations of dolphin sightings using Arcmap.

Processing of photo-identification images

Individual dolphins were identified from photographs based on patterns of nicks and notches on the trailing and leading edge of the dorsal fin as well as secondary marks such as pigmentation, scars, rake marks, wounds and lesions on the surface of the dorsal fin. Scars, wounds and lesions on other parts of the body visible at the surface were also used when present. All photographs were qualitatively analysed for focus, contrast, angle, visibility and proximity of the fin and the best photos of each individual were retained. Rigorous grading of photos was not performed for the purpose of this project as the objective was to identify the maximum number of individuals and therefore rules were relaxed (to an extent) around angle and partial fins being obscured by water, with these photos being retained where they could be used to identify an individual.

Proportion of distinctly marked individuals in the population

Individuals were categorised by the degree of marks on the dorsal fin as either distinctive (D1), subtle (D2) or clean (D3), examples given in Figure 1. The overall number of clean fins was calculated for each group and for each day, however, the same clean fin individuals could potentially have been resighted between days as they had no distinguishing features.

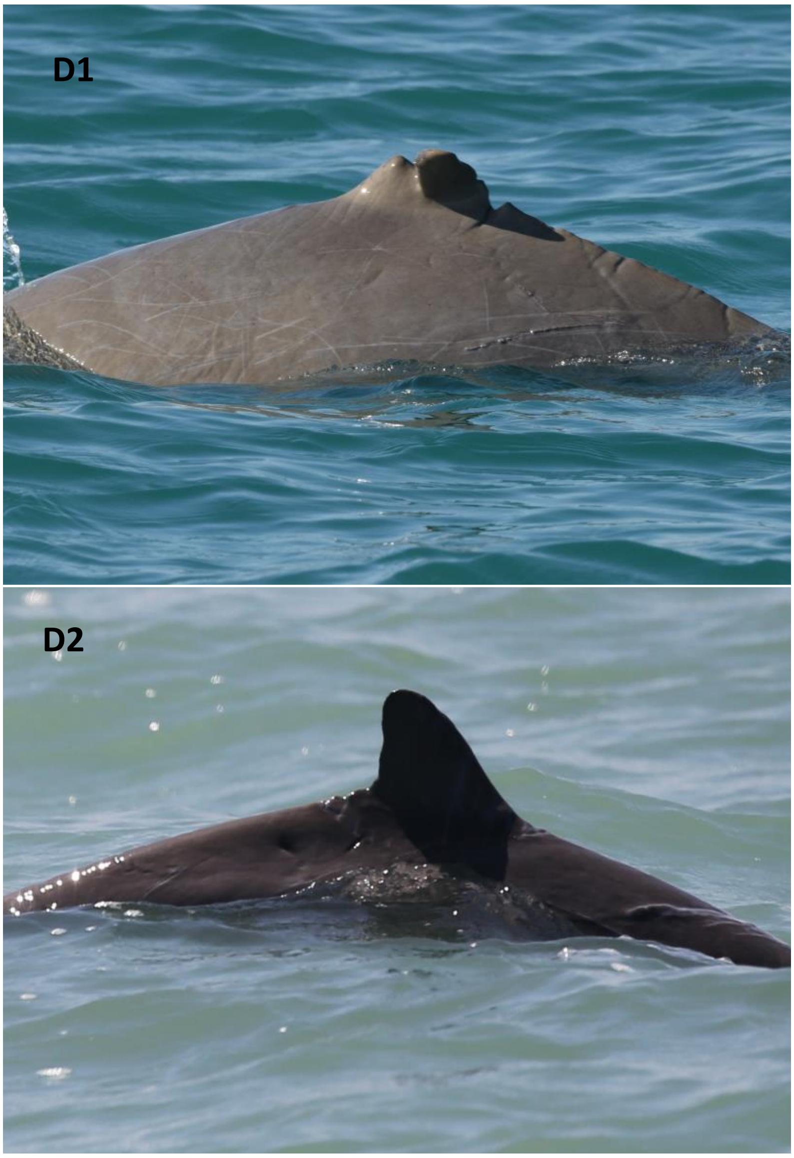

Figure 1. Examples of dorsal fins that are distinctive (D1), subtly marked (D2) or unrecognisable and 'clean' (D3).

Identification and resighting rates

All images and sighting information were entered into the DolFIN database. Attempts to match individual dolphins to those already in the photo-identification catalogue were made by a researcher. If a match was not made, then the individual was added to the photo-identification catalogue and given a new ID code.

Results

Survey effort and encounter rates

A total distance of 754 km was covered during 54 hours over the 4 days of the census that included both the transect line and the non-survey effort component (Figure 2). This included 439 km and 32 hours of survey effort on set transect lines. The prevailing wind during the survey was strong easterlies in the mornings with a Beaufort sea state >3, this resulted in most of the survey conducted at high tide in the afternoons when the Beaufort sea state <3. The planned transect lines did not extend across to the Eastern side of the Bay during high tide which resulted in the vessels searching for dolphins beyond the transect lines in areas that are known to be preferred foraging habitat for snubfins e.g. creeks (Figure 2). Further, the pearl farm lease precluded following the transects and surveying most of the western side of the Bay (Figure 2). This resulted in more effort on the transects in the northern part of the Bay.

A total of 169 dolphins including calves and including resights of the same individual(s) over multiple days) were sighted through the course of the census, 113 while on transects and an additional 56 off transects (Figure 3). This gave an encounter rate of 0.22 snubfins per km using the total track effort. When only the data from the transect lines was used, this resulted an encounter rate of 0.25 dolphins per km of transect line.

Distribution of sightings and group sizes

A total of 35 snubfin dolphin groups were sighted over the census period with group size ranging from one to 20 individuals with a mean of 4. Most dolphin sightings occurred in the north-eastern portion of the Bay (Figure 2), with higher densities apparent around Crab Creek and the extensive mud flats in water <5 metres (Figure 2). Snubfin dolphins were the only species observed by DBCA vessels during the census; however, bottlenose dolphins were sighted during the CTO vessel survey in a similar area to the snubfins, in the north-eastern part of the Bay.

Photo credit: Grace Maglio Roebuck Bay Working Group Coordinator and trained Dolphin Watch volunteer was onboard Absolute Ocean Charters vessel and photographed a bottlenose dolphin.

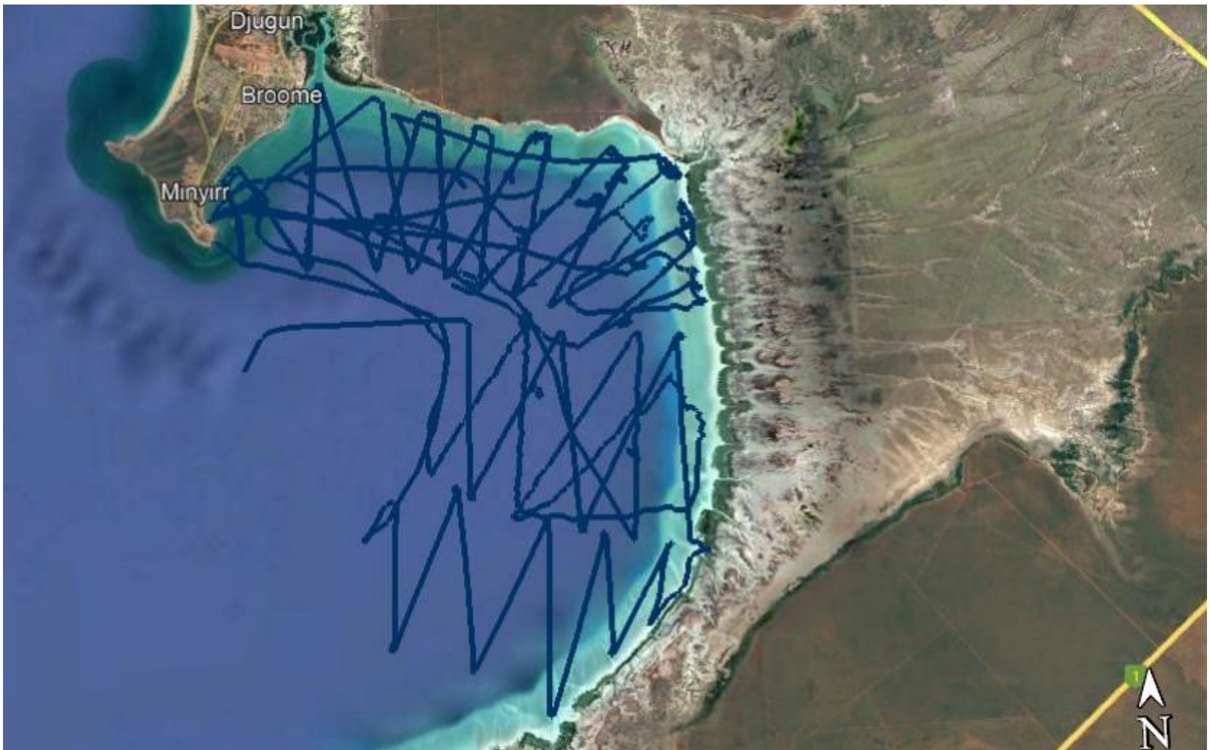

Figure 2- All survey tracks taken from the GPS units on the three DBCA vessels.

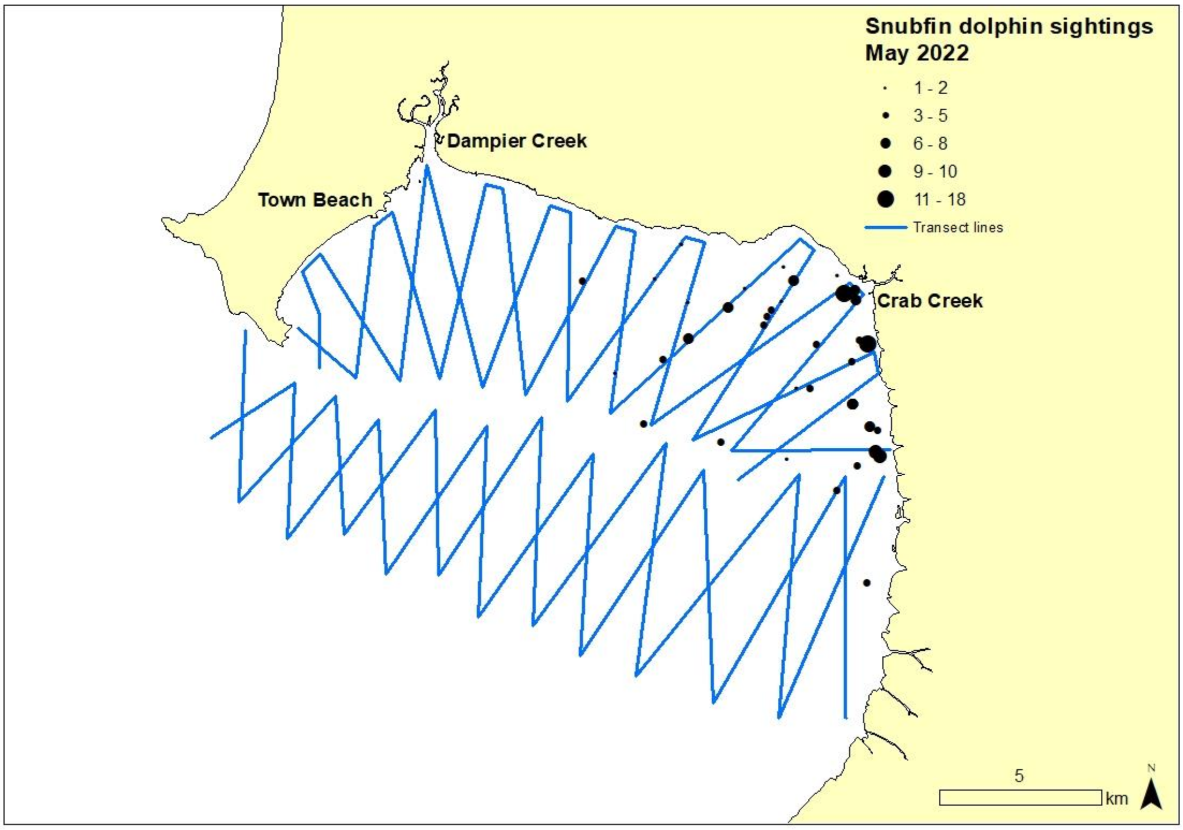

Figure 3–Snubfin dolphins sighted with group size represented in black circles by size and transect lines depicted in blue.

Identification and resight rates

Once duplicates were removed, the census resulted in 72 marked individual snubfin dolphins directly identified from photo-identification images and 15 'clean' fins and calves, giving an overall count of 87 present in the Bay during the census. Of the 87 snubfins sighted 47 (54%) were considered distinctively marked (D1), 25 (29%) subtly marked (D2) and 15 (17%) clean fins (D3) that would be unrecognisable if sighted again. By summing those in the D1 and D2 categories 83% of the snubfins sighted (72 of 87) were marked. Of the 72 individual snubfins sighted and identified, 44% (32) were resights, meaning they have been sighted in one or more previous surveys of Roebuck Bay.

Table 1 – Resighting history of the individuals that have been previously identified and are in the photo-identification catalogue/Finbook and new individuals first sighted in the 2022 census.

ID	First seen	Last seen	Sighted 2022	# of sightings
oh301	02/10/2013	05/04/2019	X	10
oh306	02/10/2013	05/04/2019	2/05/2022	7
Oh319	04/10/2013	18/07/2014	2/05/2022	5
oh320	04/10/2013	05/04/2019	X	4

ID	First seen	Last seen	Sighted 2022	# of sightings
oh324	04/10/2013	06/04/2019	3/05/2022 (both Linygurra & Jurrwayi)	3
oh330	05/10/2013	06/04/2019	X	8
oh340	05/10/2013	04/04/2019	X	19
oh365	11/10/2013	06/04/2019	X	4
oh388	20/10/2013	05/04/2019	X	18
oh400	25/10/2013	06/04/2019	X	11
oh406	01/11/2013	04/04/2019	X	16
oh444	16/10/2013	04/04/2019	X	4
Rb013oh	12/06/2009	03/04/2014	3/05/2022	6
Rb020oh	07/05/2007	19/05/2010	3/05/2022	4
rb021oh	30/07/2008	04/04/2019	X	4
Rb024oh	01/07/2009	29/05/2018	2/05/2022 3/05/2022	18
rb025oh	08/05/2007	06/04/2019	3/05/2022 4/05/2022 6/05/2022	27
rb032oh	30/06/2009	09/04/2014	3/05/2022	11
rb035oh	25/07/2008	31/03/2014	2/05/2022 3/05/2022	10
rb036oh	30/06/2009	06/04/2019	2/05/2022 3/05/2022	11
rb041oh	30/06/2009	06/04/2019	3/05/2022	9
Rb059oh	12/08/2009	30/04/2014	2/05/2022	12
rb069oh	19/05/2010	05/04/2019	3/05/2022	26
rb104oh	10/07/2009	05/04/2019	X	7
Rb113oh	47/05/2007	04/05/2022	2/05/2022 4/05/2022	13
rb120oh	01/09/2009	05/04/2019	2/05/2022	2
Rb138oh	11/09/2012	03/04/2014	2/05/2022 4/05/2022	4
rb182oh	06/07/2014	06/04/2019	X	6
rb194oh	23/02/2015	04/04/2019	X	2
rb204oh	29/05/2018	05/04/2019	X	3
rb206oh	29/05/2018	04/04/2019	X	2
rb207oh	29/05/2018	04/04/2019	X	2
rb215oh	18/06/2014	04/04/2019	4/05/2022 (both Ngari and Linygurra)	3
rb217oh	04/04/2019	02/05/2022	4/05/2022	3
rb218oh	04/04/2019	04/05/2022	2/05/2022 4/05/2022	3
rb224oh	05/04/2019	04/05/2022	2/05/2022 4/05/2022	3
rb225oh	28/07/2014	02/05/2022	2/05/2022	3

ID	First seen	Last seen	Sighted 2022	# of sightings
rb226oh	05/04/2019	06/04/2019	2/05/2022	3
rb235oh	04/04/2019	04/05/2022	4/05/2022	4
rb243oh	28/07/2014	02/05/2022	2/05/2022	3
rb250oh	05/04/2019	02/05/2022	2/05/2022	3
rb251oh	04/04/2019	04/05/2022	2/05/2022 4/05/2022	4
rb256oh	31/03/2014	06/05/2022	4/05/2022 6/05/2022	4
rb270oh	06/04/2019	03/05/2022	3/05/2022	2
rb272oh	06/04/2019	02/05/2022	2/05/2022	2
rb274oh	05/04/2019	02/05/2022	2/05/2022	2
rb276oh	05/04/2019	04/05/2022	4/05/2022	2
rb278oh	28/07/2014	03/05/2022	3/05/2022	3
rb445oh	02/05/2022		2/05/2022	1
rb446oh	03/05/2022		3/05/2022	1
rb447oh	03/05/2022		03/05/2022	1
rb448oh	03/05/2022		3/05/2022	1
rb449oh	03/05/2022		3/05/2022	1
rb450oh	03/05/2022		3/05/2022	1
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rb460oh	04/05/2022		4/05/2022	1
rb461oh	04/05/2022		4/05/2022	1
rb462oh	02/05/2022		2/05/2022	1
rb463oh	02/05/2022		2/05/2022	1
rb464oh	02/05/2022		2/05/2022	1
rb465oh	04/05/2022		4/05/2022	1
rb466oh	02/05/2022		2/05/2022	1
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rb471oh	02/05/2022		2/05/2022	1
rb472oh	02/05/2022		2/05/2022	1
rb473oh	03/05/2022		3/05/2022	1
rb474oh	03/05/2022		3/05/2022	1
rb475oh	03/05/2022		3/05/2022	1

ID	First seen	Last seen	Sighted 2022	# of sightings
rb476oh	03/05/2022		3/05/2022	1
rb477oh	04/05/2022		4/05/2022	1
rb478oh	04/05/2022		4/05/2022	1
rb479oh	04/05/2022		4/05/2022	1
rb480oh	04/05/2022		04/05/2022	1
rb481oh	04/05/2022		04/05/2022	1
rb482oh	04/05/2022		04/05/2022	1

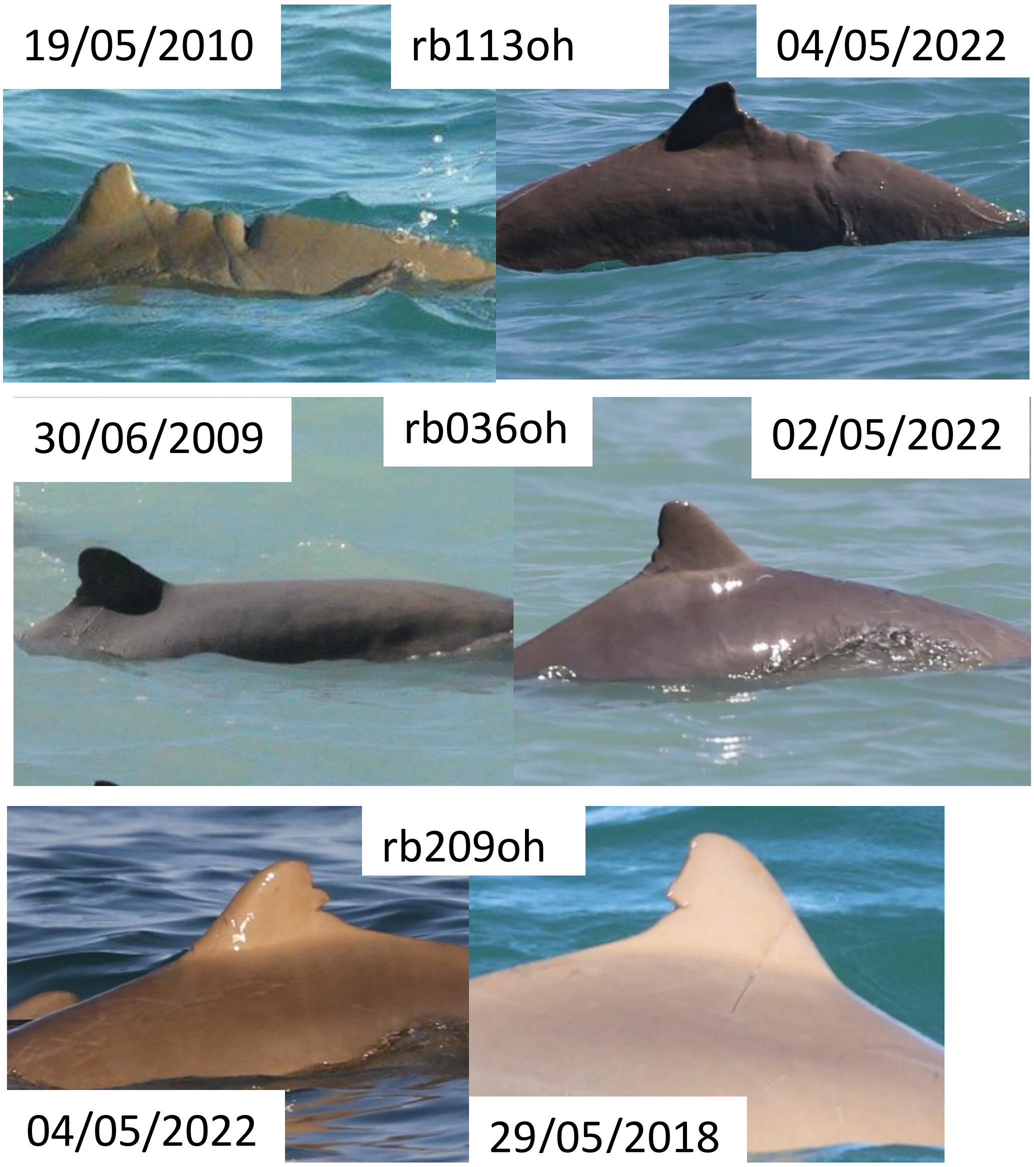

Figure 3. Individuals rb113oh and rb036oh dorsal fin shapes and marks have been stable for 12 and 13 years respectively, rb209oh has been modified in 4 years.

Photo credit: Marine Ranger Ellen D'Cruz photographed this snubfin dolphin feeding on Blue Threadfin (*Eleutheronema tetradactylum*) at the surface.

Community involvement

Bottlenose dolphins were sighted by volunteer dolphin watchers on the CTO vessel and these dolphins were not sighted by the DBCA survey vessels. This makes a valuable contribution to the census and is useful for reporting against the target of maintaining species diversity within the marine park.

Discussion

Abundance of dolphins in Roebuck Bay

Snubfin dolphins were the only dolphin species sighted during the census in Roebuck Bay, although bottlenose dolphins were sighted by volunteers during the same period. It is worth noting that while humpback dolphins were not sighted this census, this species does occur in low number in Roebuck Bay and have been reported by CTOs in 2022 (Cameron Burch, personal communication). This is important because one of the targets in the Yawuru Nagulagun/Roebuck Bay Marine Park Joint management plan 2016, is no loss of diversity of marine mammals (Department of Parks and Wildlife, 2016). This highlights the importance of data from CTOs and Dolphin Watchers with sightings of the other species being contributed improving our capacity to report on this target. Additional survey effort would be required if we did not receive this support through these additional sightings.

The other target for marine mammals in YNRBMP is to maintain abundance (Department of Parks and Wildlife, 2016) and thus was the main objective of the snubfin census. A total of 87 snubfin dolphins, 72 marked individuals and an additional 15 clean fins and calves, were sighted over the four days (resights excluded). This direct count is comparable to the previous census in 2019 where 80 marked individual dolphins were identified (96 including the calves and 'clean fins'). The results are also consistent with those reported by Brown et al. (2014a) during their month long surveys in October 2013 (100 individuals excluding calves) and in April 2014 (79 individuals excluding calves). The surveys by Brown et al. (2014a) identified 114 individuals (excluding calves) across the two sampling periods and produced a modelled abundance estimate of 130 SE± 11.9 (CI 109-155) for the Roebuck Bay population. This is similar to an earlier estimate from 2009 of 90 SE± 27.95 (95% CI 47-174) (Deb Thiele unpublished data). These surveys identified 97 individuals between May and August 2009 (Deb Thiele unpublished data). Collectively, these findings indicate that 1) the snubfin population inhabiting Roebuck Bay has remained relatively stable over this time period and 2) that the direct census approach can be reliably used to evaluate the snubfin population in the Bay.

While these different approaches have produced similar results regarding the number of individuals in the Bay at any given time, the mark-resight (MR) modelling techniques used by Brown and Thiele provide the added advantage of confidence intervals around the abundance estimate and it accounts for those that may temporarily emigrate from the study area and return, that would be missed in a rapid census. Unlike a direct count which is a single value, MR modelling accounts for the proportion of dolphins that may be missed during a survey and provides more demographic information such as survival rates and potentially information on emigration rates that a direct count census cannot. These different approaches can be used to answer different management questions, yet both provide suitable information for monitoring the long-term health of the dolphin population. Further, two of the key transects (RB1 and RB2) that were used in the census were repeated at least twice over the four day sampling period in 2022 and over the three day sampling period in 2019, which may provide data suitable for mark-resight modelling in the future. Thus, if the same sampling design and survey effort used for the 2019 and 2022 census' were repeated in future censuses (including repetition of transects RB1 and RB2 more than once), MR modelling could be used to model population size over a few censuses i.e. 9 years.

While the long-term goal should be to provide suitable data that can be used in MR modelling, the census approach is still useful for regular assessments to monitor dolphin use of the Bay, highlight high use areas and to maintain the photo-identification database and individual sighting records.

Encounter rates

Encounter rates ranged between 0.22 snubfins per km or 0.25 snubfins per km of transect line which is comparable to encounter rates for snubfins at other study sites in the Kimberley (Brown et al., 2016) and the previous census in 2019, where all dolphins were sighted at a rate of 0.19 dolphins per km transect line and snubfins at 0.15 per km of transect line. Although this was again lower than the 0.64 snubfins/km reported by Brown et al. (2016), that study concentrated only on higher density areas i.e. the northern transects RB1 and RB2. These censuses specifically included additional transects in expected low density areas to ensure full coverage of the Bay so a higher encounter rate would be expected if only transects RB1 and RB2 were used. For the purposes of this project we did not calculate encounter rate per transect. Many dolphin groups were spread out foraging and this made it difficult to estimate group size.

Identification and resighting rate

The majority (54%) of individual dorsal fins were distinctively marked with much fewer subtly marked (29%) and clean fins (17%). The dolphin population inhabiting Roebuck Bay is known to have a high proportion of marked individuals, therefore the total number of marked individuals resulting from this census should be representative of most of the population, regardless of the small number of clean fins encountered. Many of the clean fins encountered had secondary marks such as rake marks that allowed us to differentiate them from other individuals, but these markings will not persist long term and therefore they will not be added to the photo-catalogue.

It is possible that some of the clean fins were sighted across multiple days and therefore the census value may be slightly inflated but given that most of the dorsal fins were marked the minimum direct count would be 72 individuals (not including unmarked, 'clean' fins and calves). Approximately half (44%) of all snubfins sighted during the census were resights from previous surveys. Some dorsal fins have remained relatively stable over a long time period (up to 10 years) whilst others have been modified (Figure 3). Modifications to dorsal fins (termed 'evolving natural tags') are expected, particularly in a population that has a high proportion of marked individuals as new scars are acquired over time. Brown et al. (2016) estimated that 89% of the population were distinctively marked and (Smith et al., 2018) further noted that 62% of snubfins in Roebuck Bay exhibit shark bite scarring. While the high rate of scarring is an advantage to being able to identify individuals, the implications from the rate at which scarring occurs means that it may be challenging to build up long term sighting histories of individuals that would reveal life history information such as calving rate, associates and potentially life span, because as the dorsal fins are substantially modified over time the original identity of that individual would be unknown. This also means that there are many individuals in the population that, although may be resighted, cannot be matched to the existing photo-identification catalogue and will therefore be given a new identification code and added to the catalogue again. Therefore, the photo-identification catalogue may become outdated quite quickly and may also contain many more images and ID codes than is representative of the population as some individuals will receive multiple ID codes over their lifetime. Misidentification of individuals will bias mark-resight abundance estimates, and it would be prudent to exclude these data if used in future in mark-resight abundance estimation, but as the census is a snapshot in time then this should be relatively unaffected by these evolving natural tags.

Conservation and management implications

Snubfin dolphins are recognised as vulnerable by the IUCN at a species level (Parra et al., 2017) but at a local scale, snubfins are considered to be relatively abundant in Roebuck Bay (Brown et al., 2016). This has implications for conservation and management of the species as the Roebuck Bay population may provide a stronghold for the species in Western Australia. Snubfins are also valued locally by the community and are identified as a key value in the YNRBMP (Department of Parks and Wildlife, 2016). Findings from this research highlights important areas used by the dolphins for critical behaviours. This may be used by managers when considering overlap of human activities with dolphin habitat and potential pressures.

Recommendations for future research

This census demonstrates that a rapid population census done with high intensity survey effort over a short period (days) may be appropriate in monitoring trends in abundance of the population over time (years). Whilst censuses do not have the power to detect subtle changes in abundance as mark-resight do, a census provides information on the number of animals using an area at any one given time and is adequate to detect a major decline (in the order of tens of individuals). We recommend that the survey is repeated every 2-3 years (maximum 5 yearly) to ensure that management actions and causal effects could be investigated over a suitable time frame if a decline was detected. The census needs to be conducted at the same time of year to make the results comparable between years. In preparation for the 2025 census, a discovery curve should be plotted using the 2019 and 2022 data to show how many individual snubfins are identified with increasing survey effort (survey day, transect ID and transect km's) to inform the survey effort required (which transects are a priority) and over what time frame (number of days required).

Other research interests include understanding habitat use by snubfin dolphins and seasonality of their movements in and around the Bay. Data on these knowledge gaps would help inform management of activities such as fishing and boat traffic in the Marine Park. As recommended in Brown et al. (2014b) lower intensity survey effort more regularly throughout the year would reveal more about habitat use, home ranges and movement patterns. Dolphin Watch volunteers that have been trained in the Dolphin Watch app could contribute valuable data, particularly if they contribute high resolution dorsal fin photos, to complement the periodic high intensity surveys. It has also been proposed that Nyamba Buru Yawuru country managers could collect photo-identification data via the CTO vessels for regular monitoring between censuses.

Continued support for community participation in Dolphin Watch activities plays a valuable role in engaging the community and promoting not only interest in dolphin ecology and conservation but also appreciation of the Marine Park more generally.

Ethics statement

We operated under permit U10/2020-2022 from the Department of Primary Industries and Regional Development for the project 2021-26C Habitat use, distribution and abundance of coastal dolphin species that was assessed and approved by the Department of Biodiversity, Conservation and Attractions Animal Ethics Committee and the Department of Biodiversity, Conservation and Attractions and a Scientific licence under Regulation 25, Biodiversity Conservation Regulations 2018 FO25000197. The census survey was conducted with joint management partners Nyamba Buru Yawuru Pty Ltd. (NBY) country managers participating in the survey.

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Snubfin census participants included

DBCA
Shem Bisluk (PICA)
Wil Bennett (Yawuru Parks Coordinator)
Kevin Crook (Research Scientist)
Ellen D'Cruz (Marine Ranger)
Marta Espinheira (Mates Regional Trainer Marine)
Jason Menzies (Senior Officer, Behaviour Change and Public Participation)
Luke Puertollano (Yawuru Operations Officer)
Todd Quartermaine (Senior Ranger)
Holly Raudino (Senior Research Scientist)
Liam Rawlins (Senior Ranger)
Jason Richardson (Ranger Yawuru Program)
Anthony Richardson (Marine Ranger)
Peter Roe (Trainee ranger Yawuru)
Kelly Waples (Principal Research Scientist)

Nyamba Buru Yawuru Pty Ltd. (NBY)
Vaughan Lee
Julie Melbourne
Leroy Pigram

Registered and trained dolphin watchers
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Cait Westlake
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Toula Marinis
Nick Weigner
Vanessa Sadler
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Nikki Albert

Leanne Blackley
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Fairlie Bird
Lance Smith
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Mark Senekal
Kayleigh Sandford
Virginia Westwood
Janelle Laritz
Rowena Harries
Max Radvan
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Photo credit Holly Raudino: Yawuru Trainee Ranger Peter Roe (L) and Yawuru Operations Officer Luke Puertollano (R) collecting data on snubfin dolphins.

Photo credit Holly Raudino: Nyamba Buru Yawuru country manager Vaughan Lee videoing snubfins.

Photo credit Kelly Waples: DBCA staff Wil Bennett, Anthony Richardson and Kevin Crook.

Three DBCA vessels were used concurrently each day. The vessels included the DBCA *Jurrwayi*, *Linygurra* and *Ngari* and were all skippered by DBCA staff during the survey.

Photo credit: Holly Raudino. DBCA vessel Linygurra with Leroy Pigram (NBY country manager), Anthony Richardson and Ellen D'Cruz (DBCA marine rangers) onboard.

Photo credit: Holly Raudino. DBCA vessel Ngari with DBCA staff Kelly Waples, Shem Bisluk, Ellen D'Cruz and Liam Rawlins pictured.

Photo credit: Kelly Waples. DBCA vessel Jurrwayi with DBCA staff Holly Raudino, Kevin Crook and Anthony Richardson (vessel master) and Julie Melbourne (Nyamba Buru Yawuru) onboard.

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